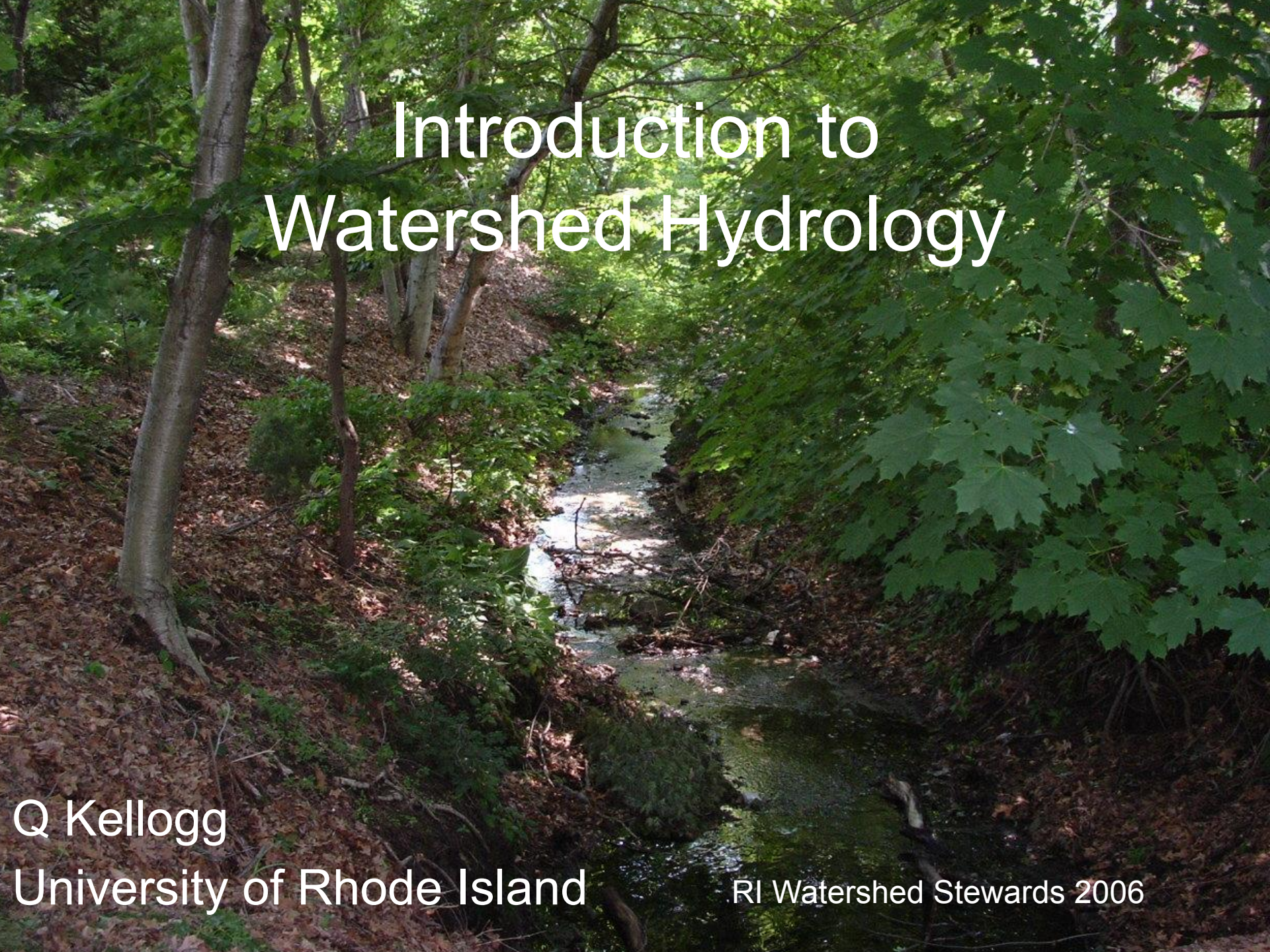




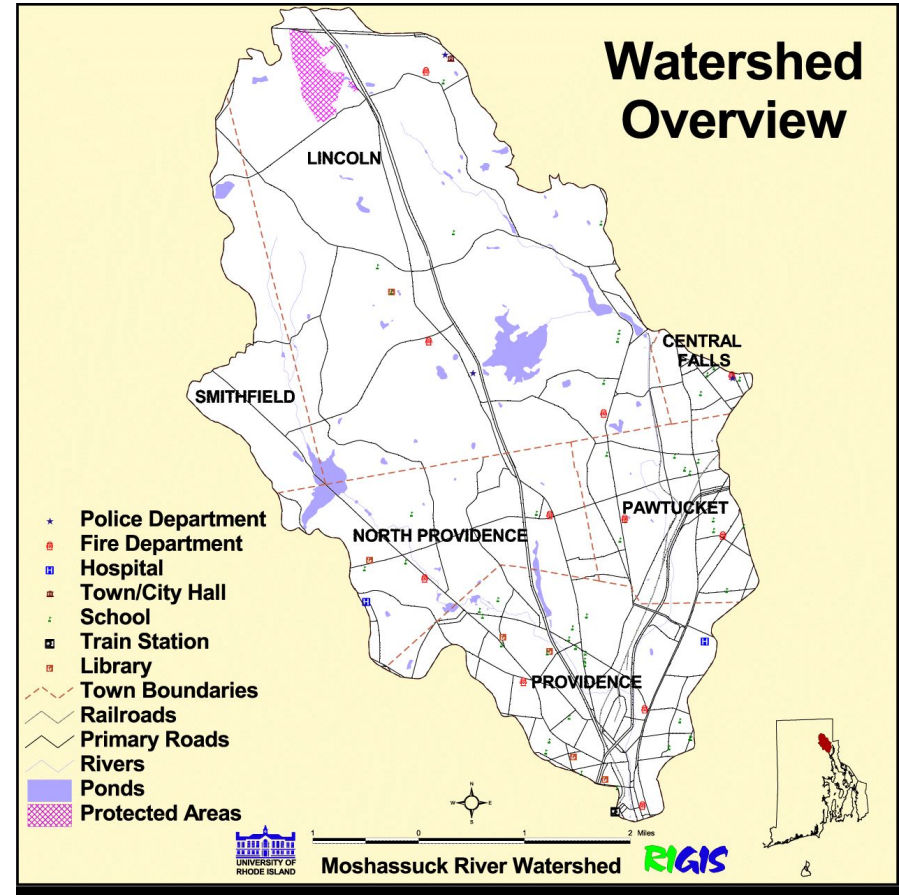
Introduction to Watershed Hydrology

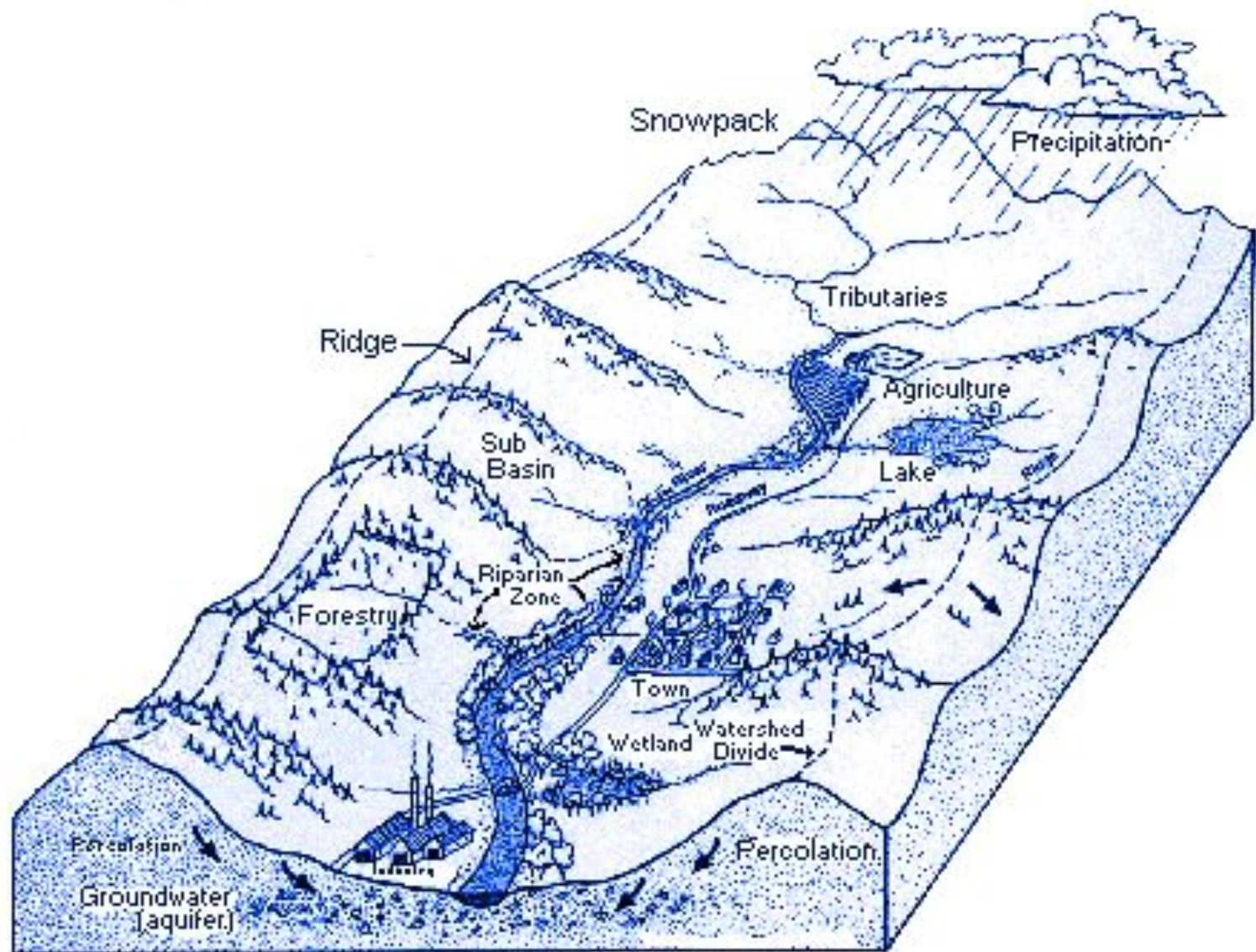
Q Kellogg
University of Rhode Island

RI Watershed Stewards 2006

Watershed = Catchment = Basin

- The area of land that drains water, sediment and dissolved materials to a common outlet.
- Watersheds are separated by divides
- Can be any size, from a few acres to hundreds of square miles
- Sub-watershed = watershed within a watershed

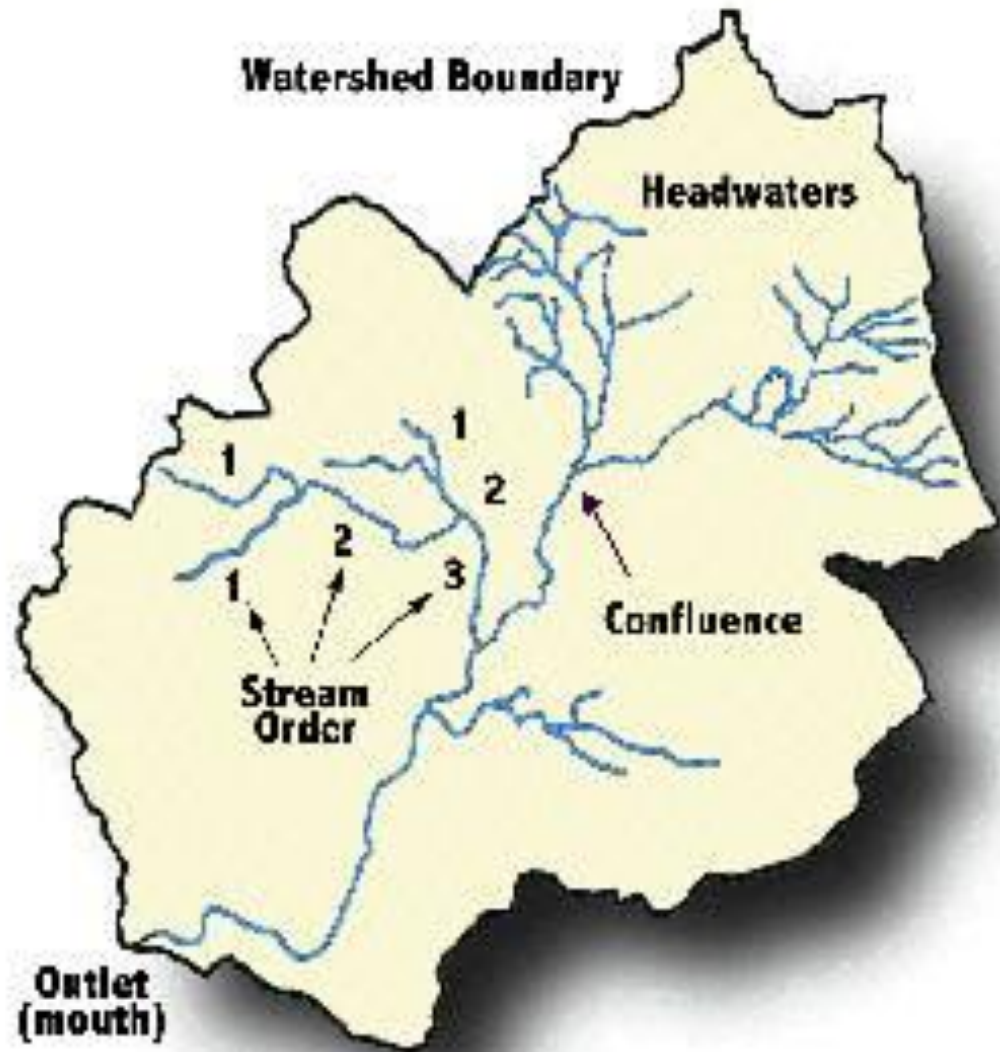




Produced by Lane Council of Government

Stream Order

- Smallest tributaries are 1st order
- Two 1st orders join to form 2nd order
- Two 2nd orders join to form 3rd order, etc.

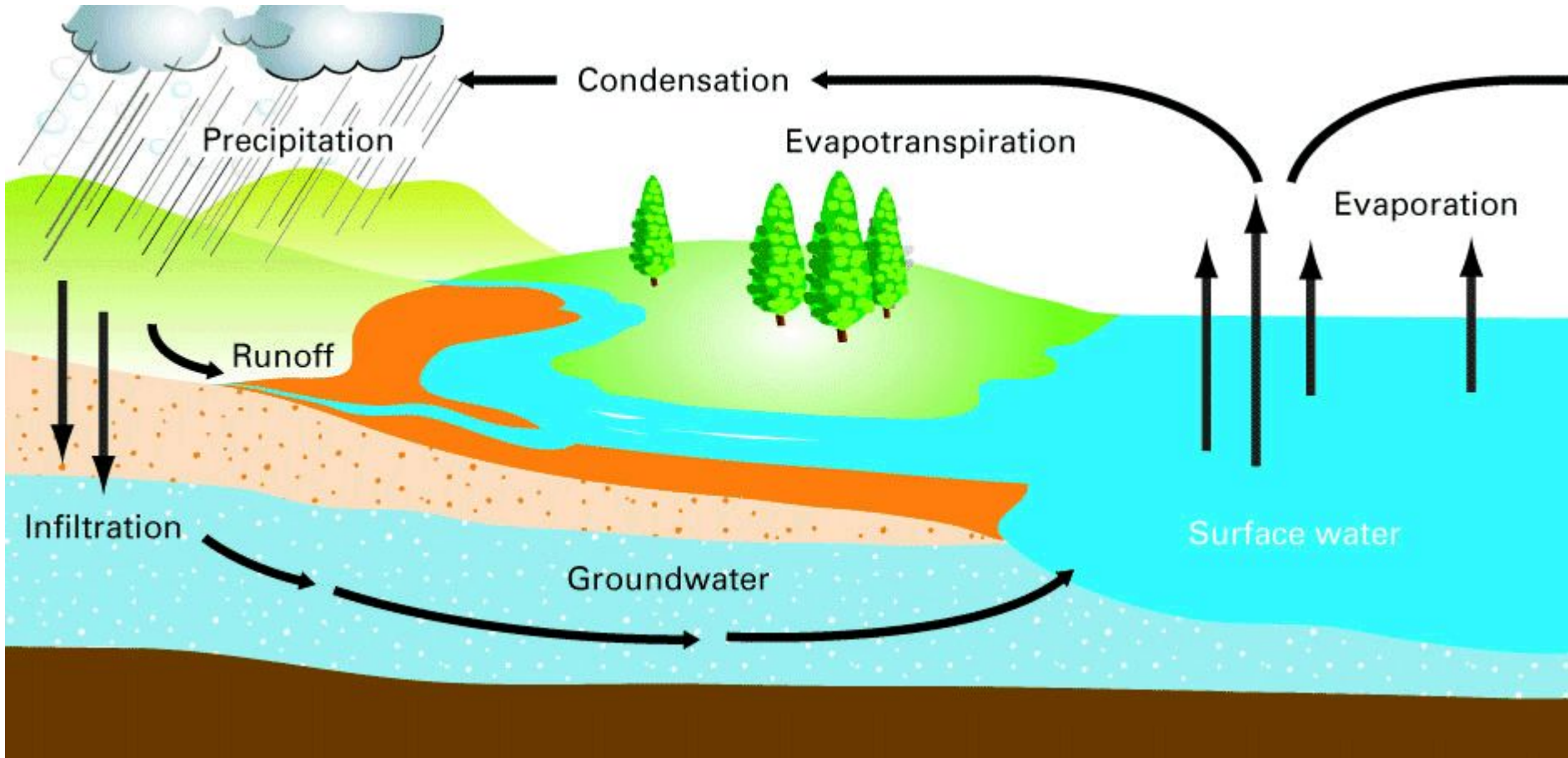


What happens downstream?

Gulf of Mexico “dead zone”

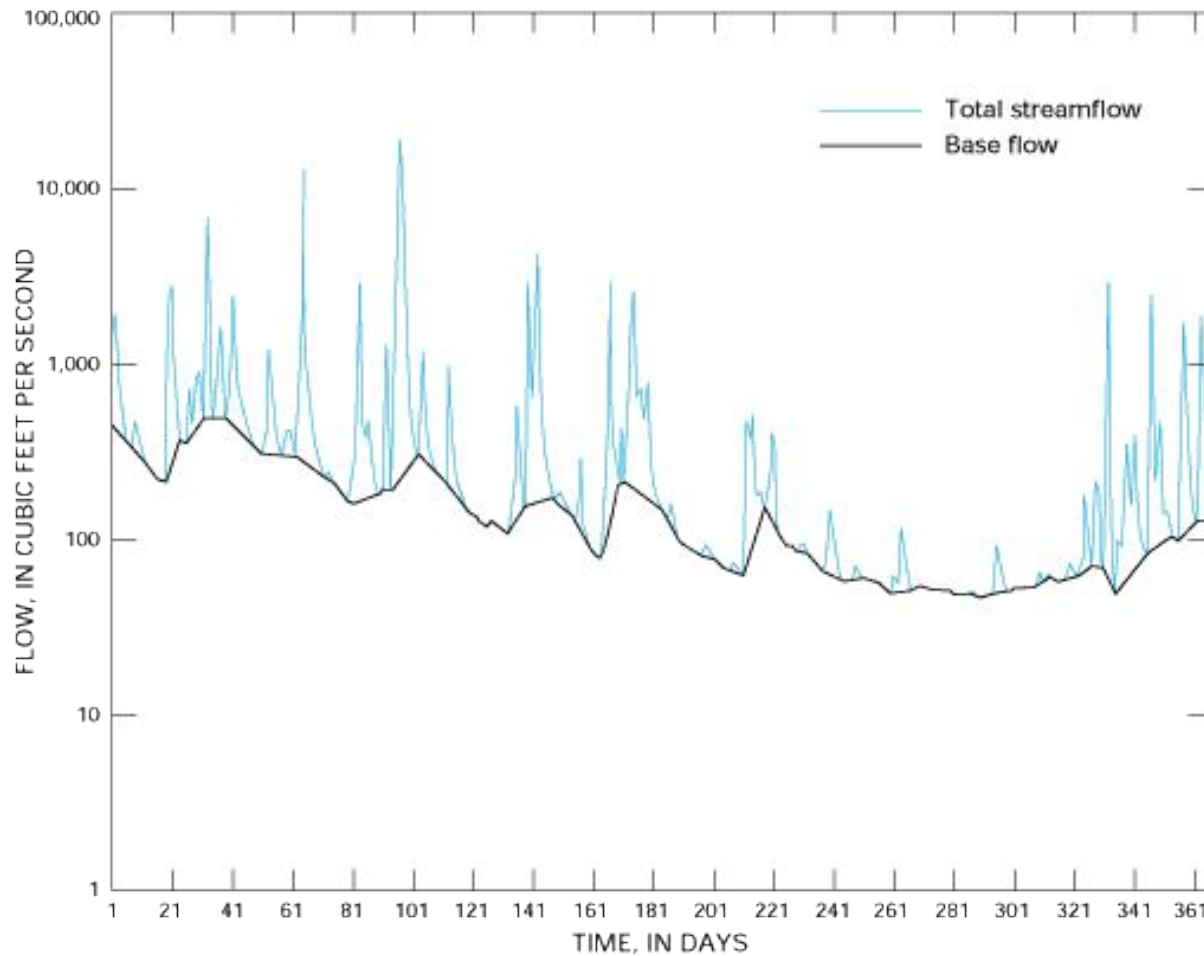


Hydrologic Cycle

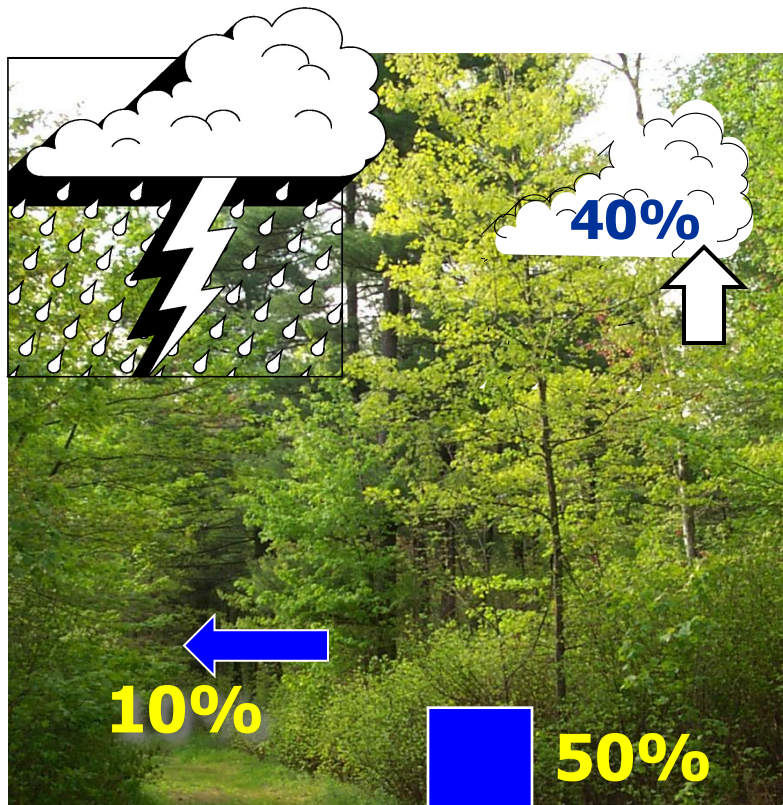


Hydrograph

River discharge vs. time

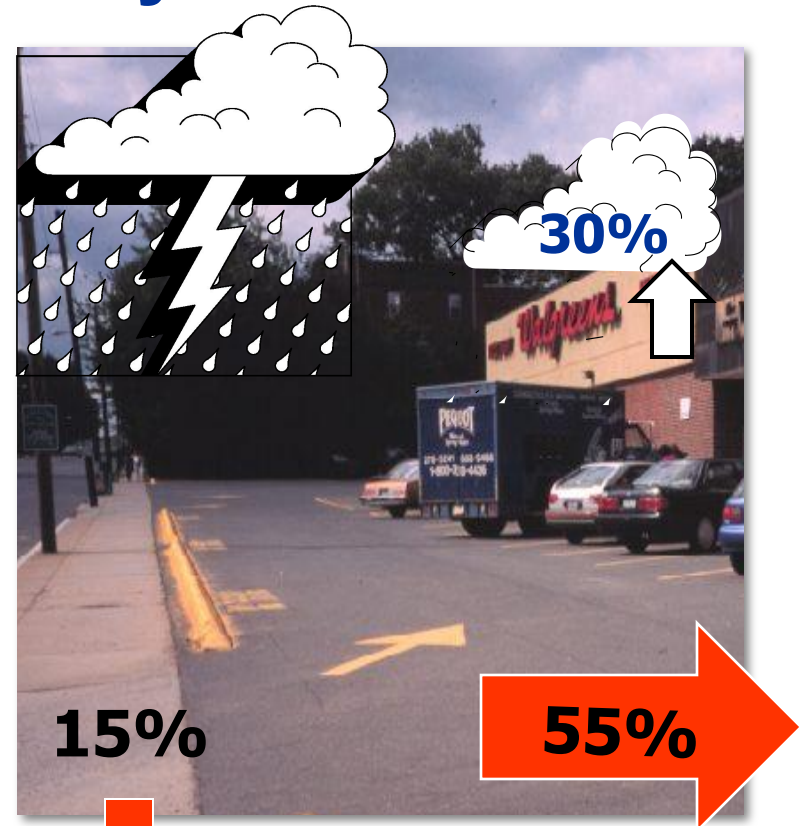


Development Impacts on the Water Cycle



Natural Landscape

- ✓ Low runoff
- ✓ High recharge
- ✓ Healthy summer stream flow
- ✓ Natural pollutant treatment



Developed

- High runoff, Low recharge
- Nuisance flooding
- Lower water tables
- Low stream flow

Hydrograph pattern is the result of:

Watershed characteristics
soils □ infiltration rates

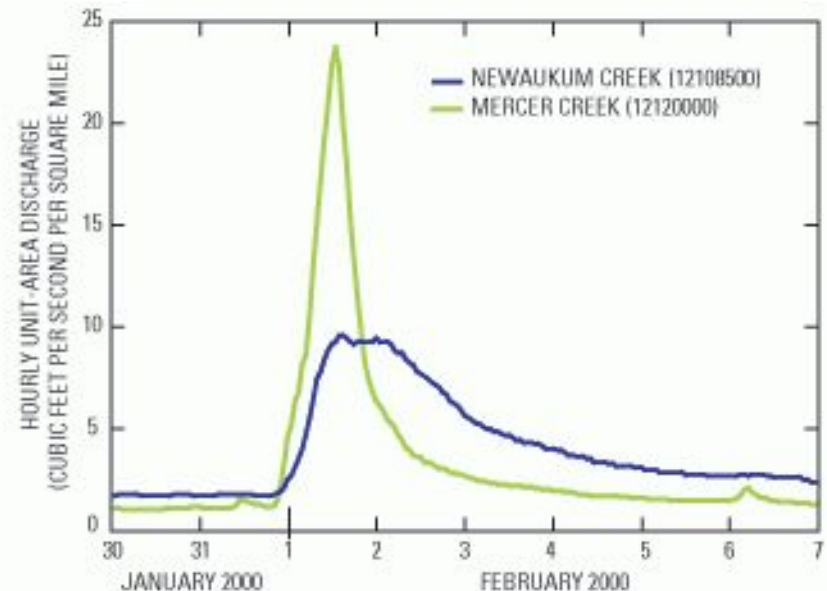
land use □ impervious
surfaces, vegetation,
wetlands

slope, shape

Climate

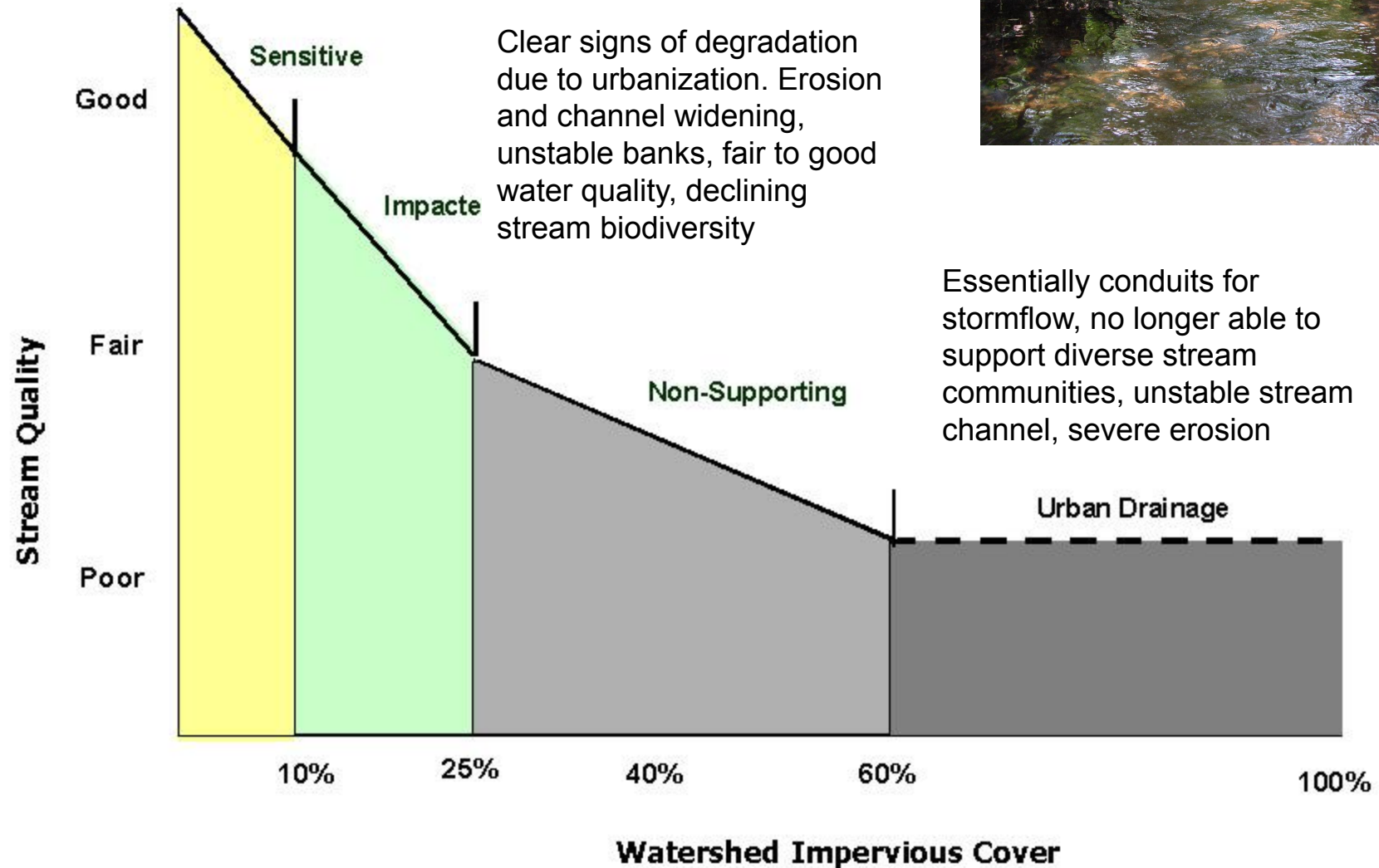
humid vs. arid
previous rainfall

Storm characteristics
intensity, duration



Streamflow in Mercer Creek, an urban stream in western Washington, increases more quickly, reaches a higher peak discharge, and has a larger volume during a one-day storm on February 1, 2000, than streamflow in Newaukum Creek, a nearby rural stream, a nearby rural stream that drains a basin of similar size.

Stable channels, excellent habitat structure, good to excellent water quality, diverse communities of fish and aquatic insects



Pollution Sources

Point Sources

Pipe outlets for wastewater treatment plants and industrial plants



Now encompasses sources that can be identified, isolated and treated at a discharge point

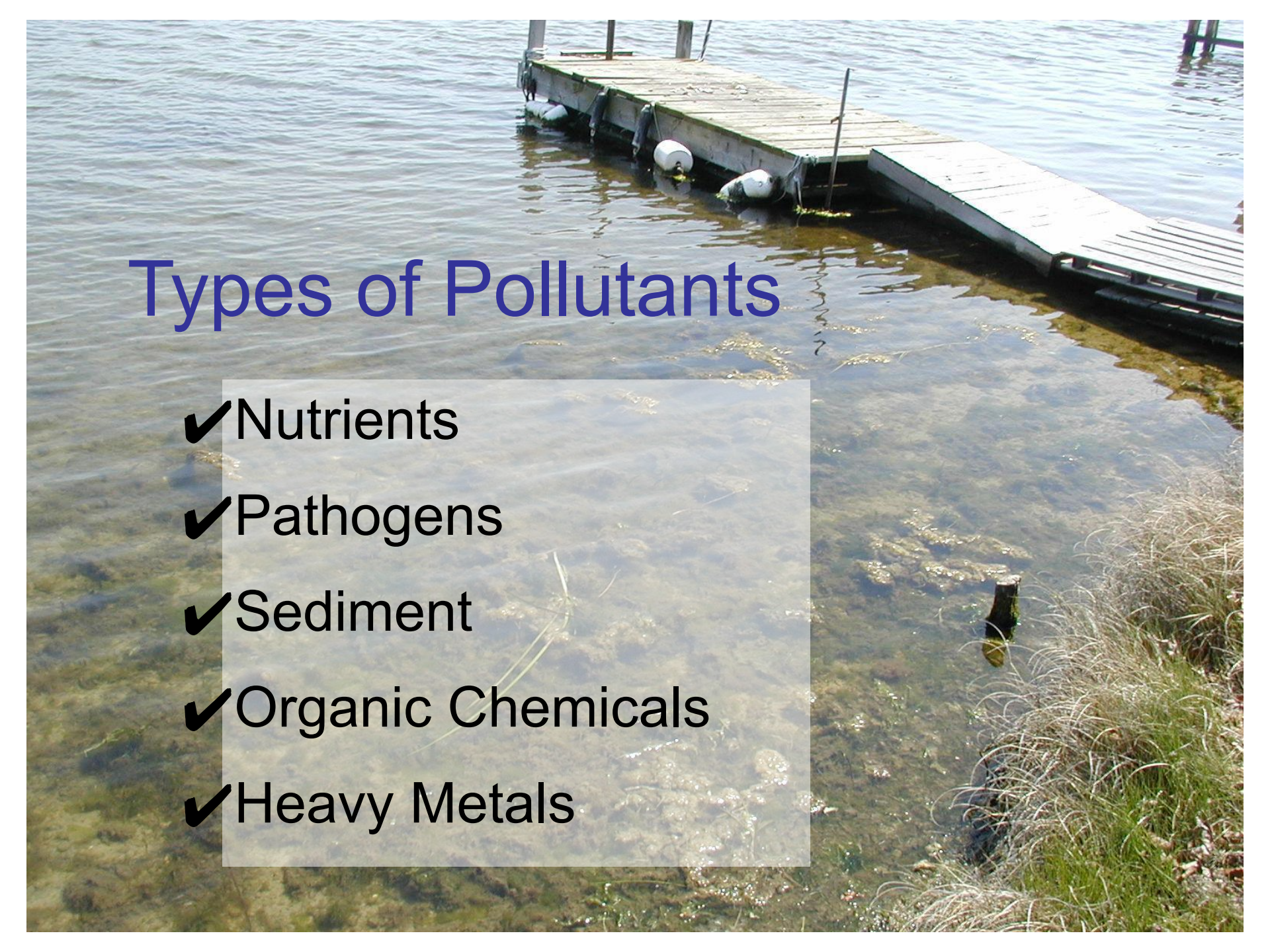


Cleanwateract.org

Non Point Sources



Contributions from
the landscape,
agriculture, urban
stormwater runoff



Types of Pollutants

- ✓ Nutrients
- ✓ Pathogens
- ✓ Sediment
- ✓ Organic Chemicals
- ✓ Heavy Metals

NUTRIENTS

Nitrogen (N) and Phosphorus (P)

Sources:

- Septic systems

- Fertilizers

- Livestock or fish processing wastes



Concern levels:

- Drinking water... $N = 5 \text{ to } 10 \text{ mg/L}$

- Eutrophication....freshwater $P < 25 \text{ ug/L}$

 - brackish water $N < ??$

Often used as a surrogate for a range of pollutants

- N in the form of nitrate (NO_3) is soluble □ groundwater contaminant

- P is sediment-bound □ surface water contaminant



PATHOGENS

Viruses, Bacteria

Fecal coliform is used to indicate presence of pathogens
...may not be reliable

Sources:

Human and animal waste

Concern levels:

Drinking water, shellfishing waters, swimming



Fecal coliform is not a health risk in itself, but is used as an indicator because it only comes from human and animal waste

May be filtered or destroyed in unsaturated soil, may travel considerable distances in ground water or surface water

SEDIMENT

Mineral and organic soil

Sources:

Construction (30 to 70 times greater than vegetated areas), crop erosion, direct application (e.g., sanding in winter)

Concern levels:

Not specified but carries other pollutants bound to sediment

Direct effects:

Turbidity, temperature changes, loss of spawning habitat



ORGANIC CHEMICALS

Hydrocarbons, pesticides, industrial solvents
(benzene, dioxin, TCE)

Sources:

Leaking underground storage tanks (LUST's),
agriculture, direct discharge

Concern levels:

parts per billion (ppb) or parts per trillion (ppt)

Transport:

Sediment bound or soluble, may float or sink



HEAVY METALS

Arsenic
Lead
Mercury
Chromium
Cadmium

Sources:

Industrial, leaded gas and lead pipes, autos, landfills

Concern levels:

Usually ppb

Many have drinking water standards

Transport:

Usually sediment-bound, higher mobility in acidic waters, soils have finite adsorption capacity



Clean Water Act

Federal Water Pollution Control Act
Amendments of 1972

Amended in 1977 □ Clean Water Act

Goal: Restore and maintain the
chemical, physical, and biological
integrity of the Nation's waters.



Regulates discharge of pollutants into U.S. waters

Requires States to set water quality standards for their waters

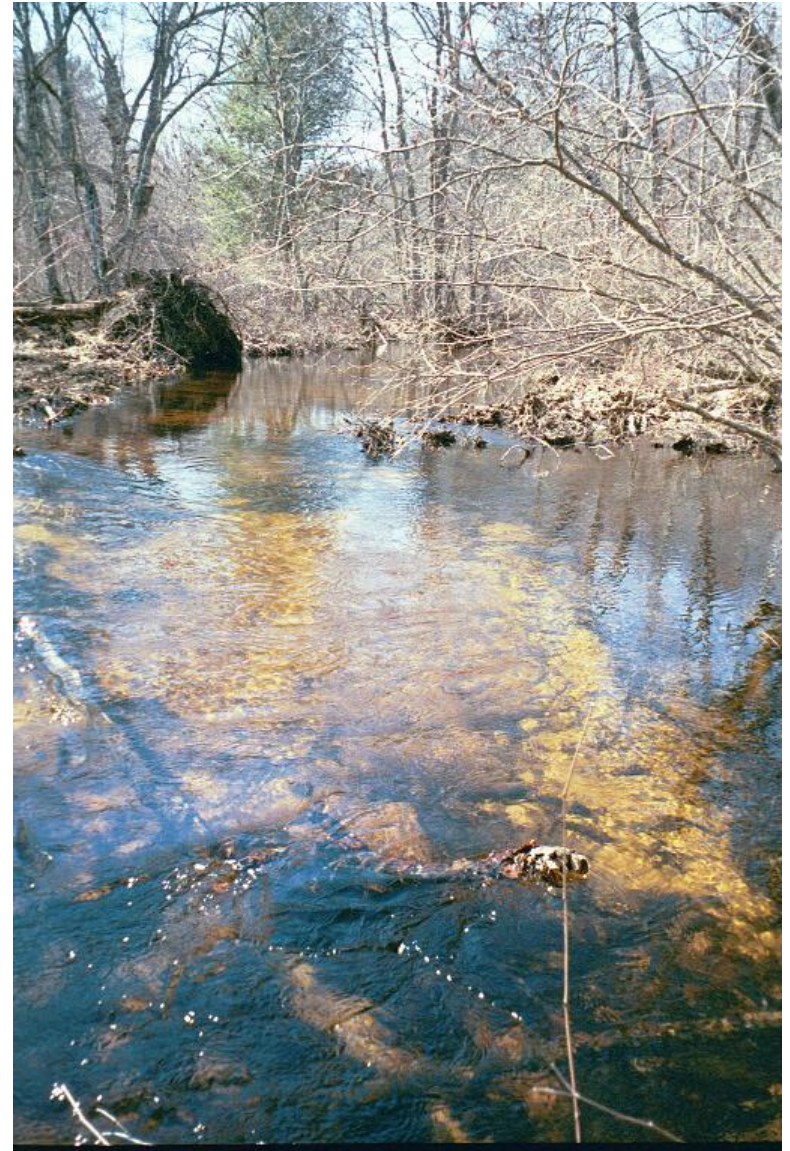
Initially, focus was on point source pollution, especially
wastewater treatment plants

WATER QUALITY STANDARDS

Defines the goals and limits for all waters within a State's jurisdiction □ making the goals defined in the WQA concrete

Steps:

- 1) Designate uses (e.g., drinking, fishing, swimming)
- 2) Establish water quality criteria
- 3) Develop and implement antidegradation policies and procedures



Topographic Map Reading

The Gold Standard
USGS 7.5 min. Quad
1:24000 scale

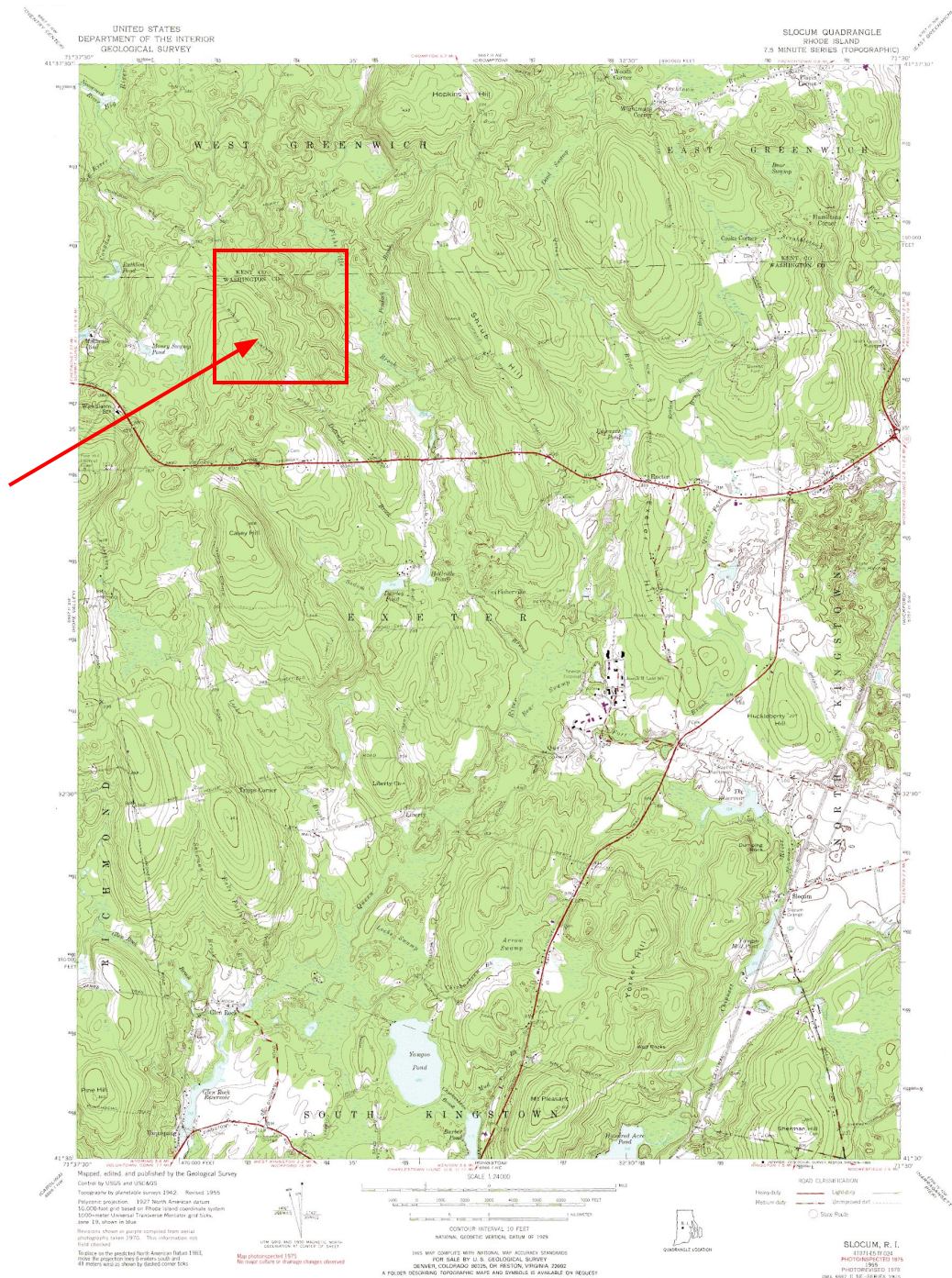
One square mile

Covers 7.5 minutes of
latitude & longitude

At the latitude of RI (41° N),
this translates to:

8.62 miles N / S

6.24 miles E / W



Metadata



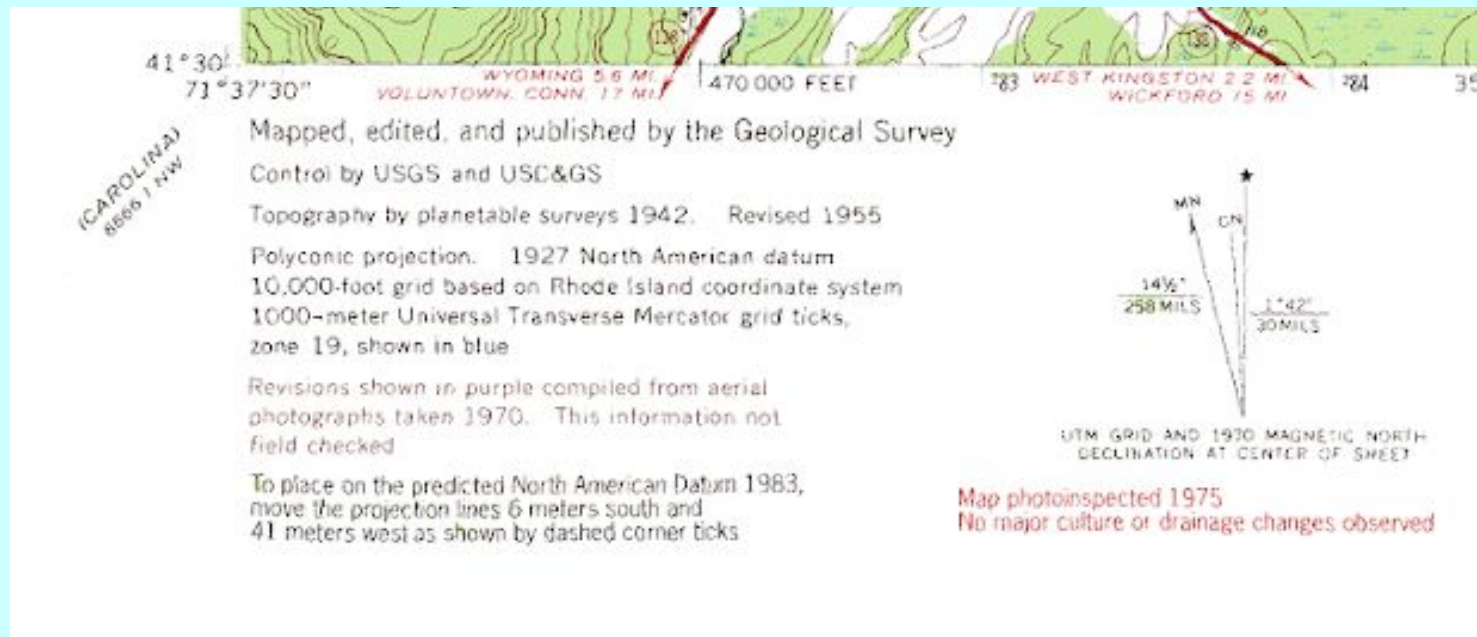
Map title

Adjoining maps

Locator Map

Dates

Metadata

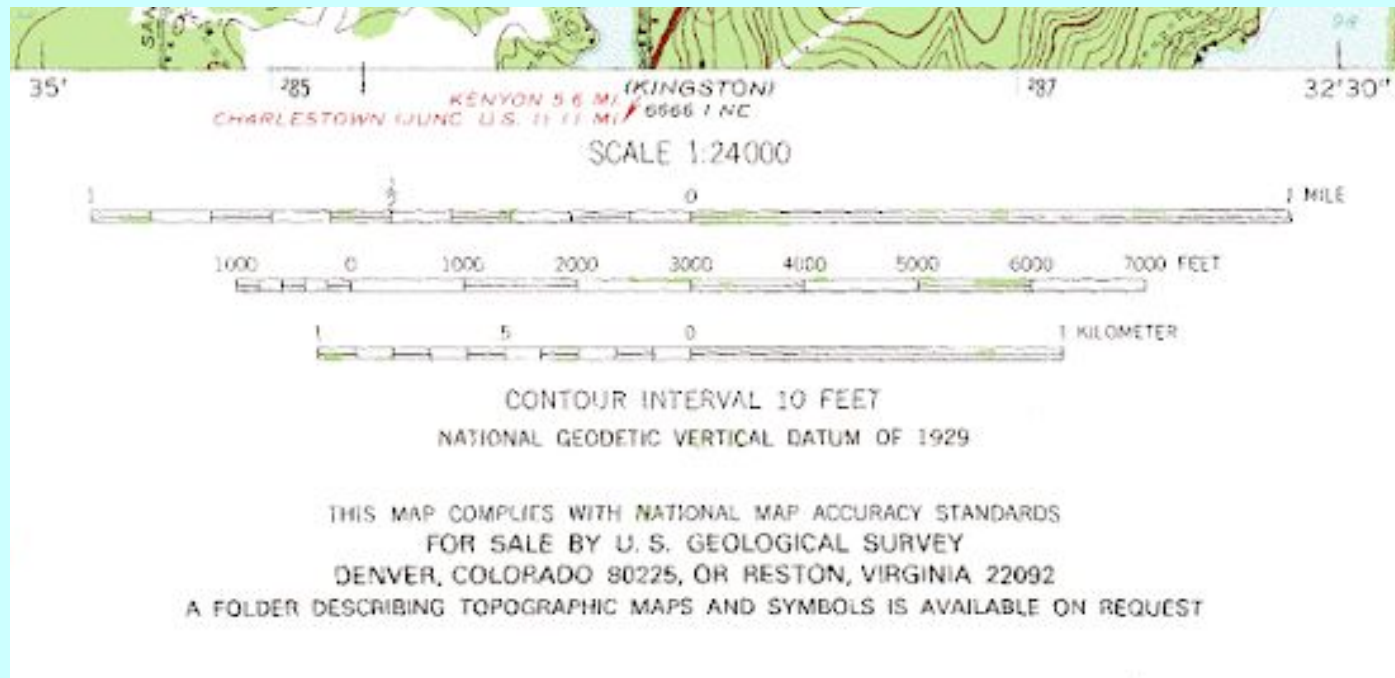


North arrow – true & magnetic

Date of topography

Revisions shown in purple

Metadata



Scale

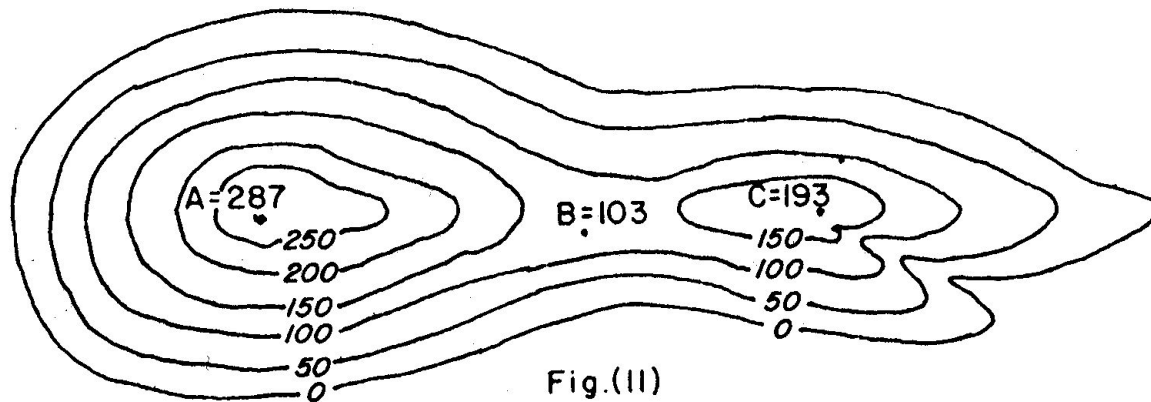
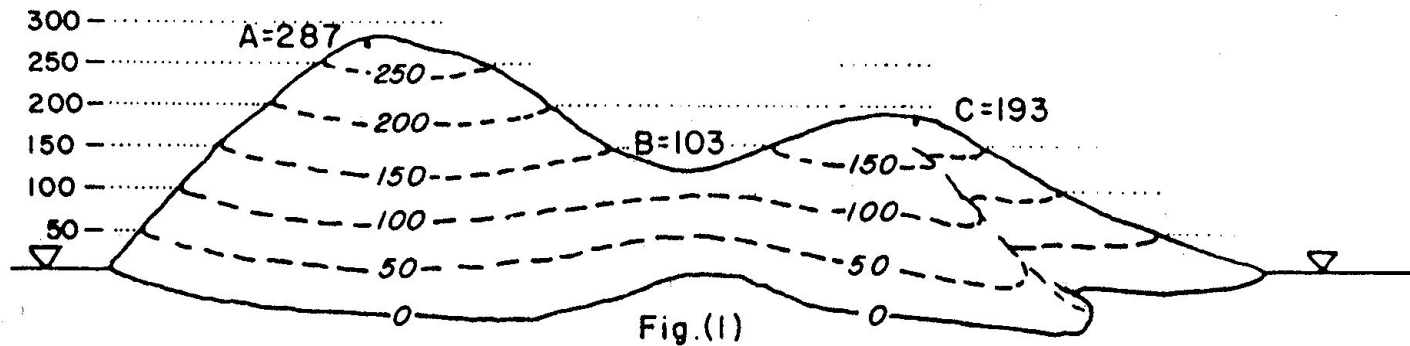
Map Accuracy Standards

reference to symbology

Contour interval

Terrain Representation

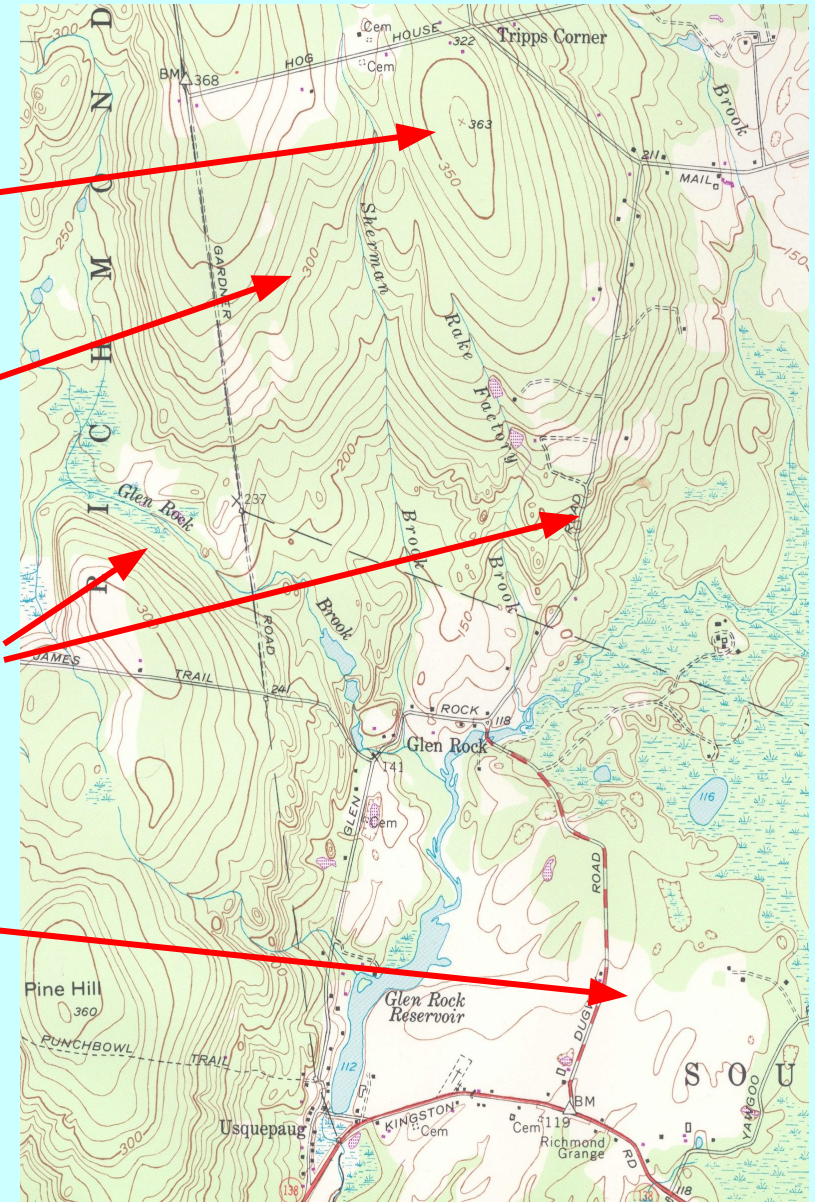
Contour line – a continuous line that connects points of equal elevation.



Terrain Representation

Rules & Concepts

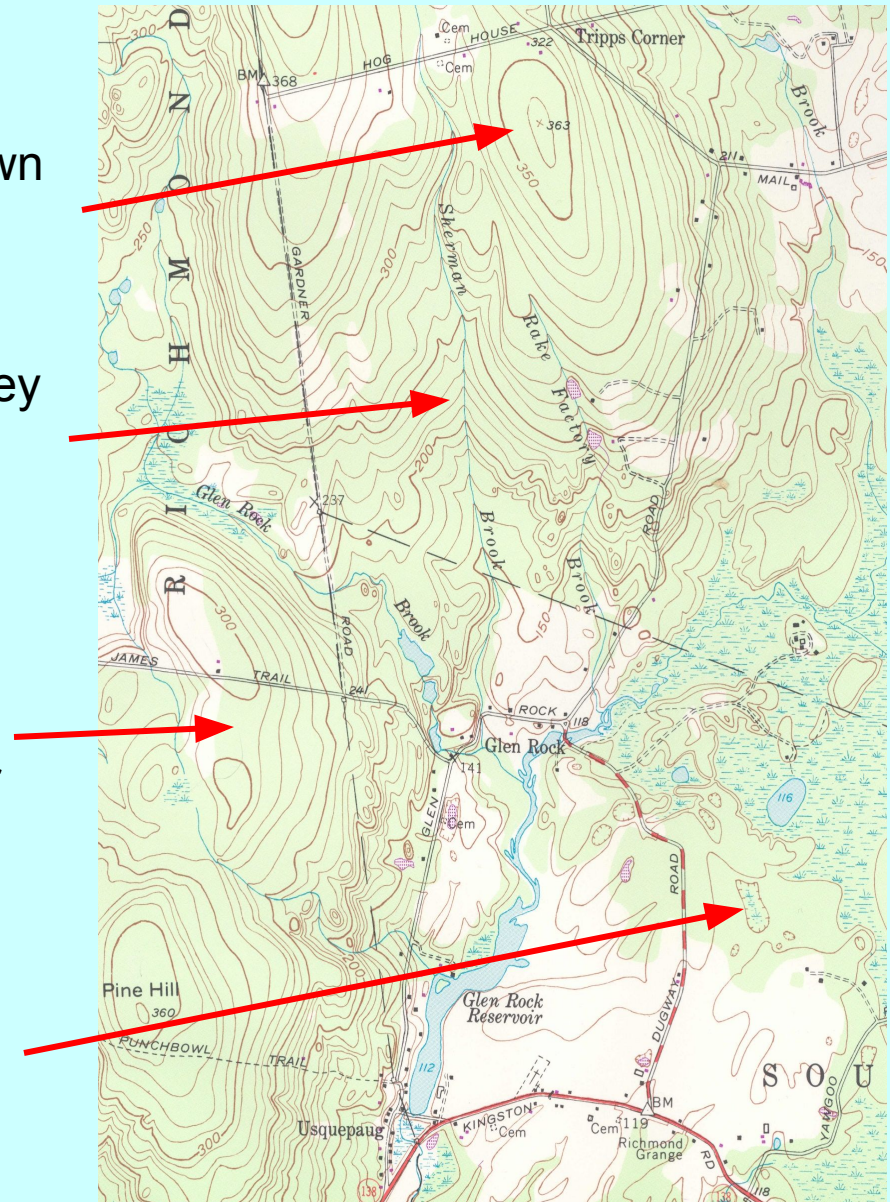
- **Hilltops** are indicated by progressively smaller, closed contours.
- Every fifth contour line is an **index contour** and is usually labeled.
- Contours close together indicate a **steep slope**.
- Contours far apart indicate a **gentle slope**.
- **Contour lines** never cross each other.



Terrain Representation

Rules & Concepts

- A **spot elevation** is a point with a known elevation.
- When contour lines cross a stream, they form a “V” that always points **uphill**.
- A **saddle** is an area, often on a ridge, between two areas of higher elevation. There is high ground in two opposite directions and lower ground in the other two directions.
- **Depressions** are indicated by closed contours with inward-pointing ticks.



Terrain Representation

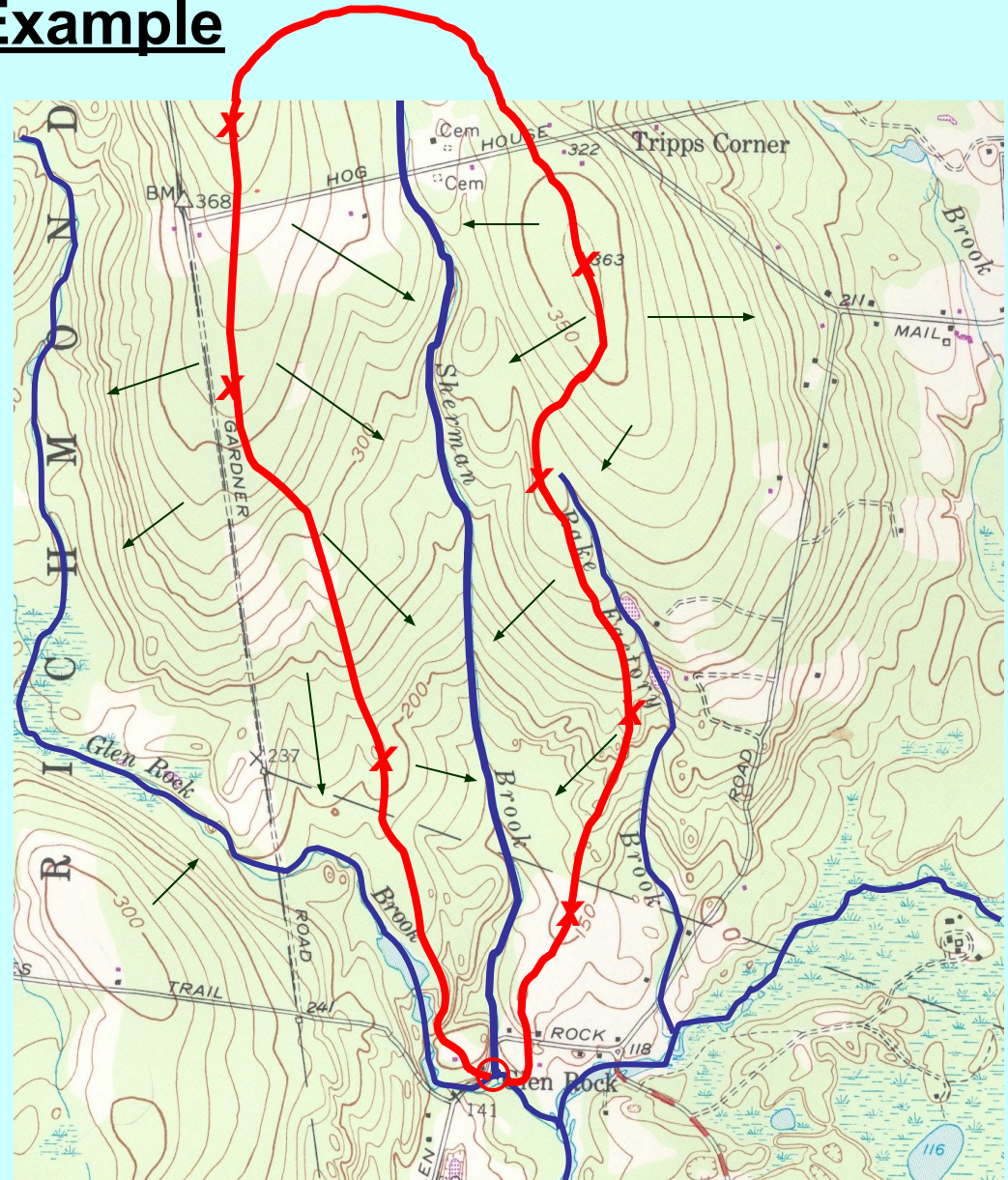
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- When contour lines cross a stream, they form a “**V**” that always points **uphill**.
- As a general rule, **water flows** downhill **perpendicular** to contour lines.

Watershed Delineation Example

Sherman Brook Watershed

1. Identify the watershed outlet. Mark with ○.
2. Highlight Sherman Brook & other nearby watercourses.
3. Try to visualize direction of flow and look for ridge lines & saddles. Mark high points with X.
4. If needed, draw arrows to indicate direction of surface flow. →
5. Trace outline of watershed beginning at outlet, connecting high points. Cross contours at right angles. Form a closed and continuous boundary.



Note town boundaries - Sherman Brook Watershed is in two municipalities